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## REVIEWS OF RECENT LITERATURE.

### GENERAL BIOLOGY.

**A Rational Vitalism.**—A most significant feature of the biological thought of to-day is the effort to place upon a solid foundation the idea of elementary vitalistic phenomena as thinkable processes, which are independent of all known chemical and physical forces and as worthy of scientific recognition and as capable of exact statement as is gravitation or chemical affinity.

Driesch in a recent paper<sup>1</sup> seeks to furnish a proof of the existence of vitalistic phenomena of an elementary character, not by bringing forward new facts, but by the interpretation of already published observations in the domain of experimental morphology. It should be at once mentioned that, whereas Driesch combats strongly the absolute dominance of the mechanical theory of life processes, as confusing that which is merely understandable with that which is actual and capable of proof, and so as becoming dogmatic and misleading, he clearly discountenances the older uncritical vitalism with its implied supernatural teleology and its absence of all well-defined relation to the fundamental ideas of causality, energy, matter, etc.

The author looks to the problem of localization of morphogenetic processes as the divining rod by the aid of which we may be led into this new land of promise. Why is it that the archenteron of the well-developed gastrula of *Sphærechinus* becomes constricted in two places, thus marking off from one another the stomodæum, mesenteron, and proctodæum? Moreover, why do similar constrictions occur in the archenterons of each of the two half embryos, which result from the dividing in the equatorial plane of a well-developed gastrula in such wise that each half contains its share of the endoderm as well as of ectoderm? The wound heals, and the constrictions occur in each embryo at the same proportionate distances from the poles of the embryo as in the normal larva. The cause of this phenomenon, and of others similar to it, is not to be found,

<sup>1</sup> Driesch, H. *Die Localisation morphogenetischer Vorgänge: Ein Beweis vitalistischen Geschehens.* Leipzig, 1899. 82 pp. Published also in *Archiv für Entwicklungsmechanik*, etc., Bd. viii, 1, pp. 35-111, 1899.

according to the author, in any known chemical or physical force, but in an hypothetical *Fernkraft*, an elementary vital force which acts at definite distances from fixed points, like the active pole of the egg, or from the median-ventral line of the bilaterally symmetrical embryo, to determine in some definite manner the form.

Various localization problems of a special nature are discussed. Treating of cleavage among the echinoderms, the author deduces from his own and others' experiments upon the segmentation of egg fragments and of isolated blastomeres, the displacement of blastomeres, etc., the conclusion that the protoplasm of the egg, in general, depends upon a certain factor, inherent in the protoplasm, upon which the cleavage and a general regulation of the egg mass depend, and he also asserts as proved the proposition that all parts of the cytoplasm during segmentation are respectively similar as regards their morphological "prospective potency," and that the nuclei are likewise similar each to each. From this standpoint he reasons that the earliest differentiation of the embryo is determined as to its position by a correlating force, this conclusion being quite opposed to the idea that the protoplasm of the egg consists of manifold elements arranged in some sort of a typical specific position, which bears a certain definite relation to later differentiation. If then the structure of the egg consists, as is assumed, merely of a polarity, namely the possession of a chief axis with unlike poles and one at right angles to it which also has unlike poles, how can one explain the localization of a variety of structures in the embryo not only at the poles but at any possible, though typical, position in the embryo? Likewise the arrangement of the bilateral groups of mesenchyme in the echinoids in definite typical positions, the appearance of the mouth in its proper place, independently of any possible contact stimulus proceeding from the archenteron, the localization of the ciliated band of *Bipinnaria*, all are problems of localization of a similar nature.

The eggs of ctenophores and of mollusks naturally present certain difficulties, since in them no regulation of the entire egg mass is proved and a definite complex structure of formative materials within the ovum is conceivable. Nevertheless the author believes that the power is there, though dormant, and that a sort of precocious activity of the localizing force may explain the difference between these eggs and those of the echinoderms, *Amphioxus*, etc. Moreover, if a complicated structure is assumed for the ovum of the ctenophore or of the mollusk, then the very structure of such typical complex nature presupposes in oögenesis a localizing agency.

Another well-marked case in which this same phenomenon is manifest is the "reparation" of *Tubularia*. How is it that the two circlets of buds of the new hydranth arise not on the surface of the wound of the transected hydrocaulus, but always at a definite distance from that surface?

Finally, the results of Morgan's experiments upon regeneration in *Planaria*, which show that each of the several pieces cut from one individual becomes transformed by a shifting and differentiation of the protoplasm into a small and typically proportioned worm, likewise demand for an interpretation some controlling factor with localizing power.

In a discussion of the idea of localization in general, it is shown that the phenomenon of determination of position of parts may or may not require for its explanation the postulate of a localizing force of an elementary kind. In many instances of localization phenomena among plants, as in the transformation of indifferent leaf germs into foliage leaves or bud scales by the influence or absence of light, the localizing power consists in the direct action of a definite external stimulus upon parts which possess equal, though restricted, possibilities. In such cases as this, and in ordinary regeneration among animals, like the restoration of an amputated leg in *Triton*, localization is determined by the nature and position of the external stimulus (light, heat, etc.) or by the limited "potency" of the parts. Therefore no localizing action of an elementary nature occurs in these instances.

It is shown that the localization phenomena which are independent of specific external stimuli and of a simple elementary nature are confined to that association of cells or elementary structures of whatever kind which Driesch terms a harmonic equipotential system. In an equipotential system, in general, every part has an equal "prospective potency" with every other, *i.e.*, equal power as to the possibilities of its development. The willow twig, for example, is an equipotential system in which every part has indeed an equal prospective potency with every other; but here the power is limited to the production of sprouts and roots that are indefinite in number and have no specific relation to one another. An equipotential system which is thus restricted in its possibilities is called a determined equipotential system. In the segmenting egg of an echinoid or in the stem of *Tubularia*, however, every "effect" appears only once or a limited number of times, and stands in a definite relation to all other "effects." Such are accordingly called harmonic equipotential

systems, and it is the phenomena of localization which occur in such systems that require an elementary vitalistic force for their explanation. An organization as regards primary axial relations, which is present at the beginning of development, is considered to be an essential part of the conditions of every harmonic equipotential system, and it is therewith an essential presupposition of its differentiation. Moreover, the activities which occur in such a system as the result of some disturbance of the course of development indicate the existence of a regulatory power, which is a fundamental character that is intimately associated with the localization of differentiation.

In defining formally the localizing action which takes place in harmonic equipotential systems, Driesch makes first a statement in terms of cause and effect. Thus we may suppose one of the terminal points of the axis of any structure under consideration to be the seat of forces which act at a distance. This place may be said to exert an influence, to which that part upon which it works must be able to respond. Reverting to the constriction of the archenteron of the gastrula of echinoderms, the author claims that the cause of the constrictions lies in the "potency" of the system; the *Fernkraft*, acting through a definite typical distance, determines where the constrictions shall be. The distance, however, is not absolute, but proportionate to the size of the system. As the system becomes modified and more complicated, new points of reference are formed, from which still other sorts of *Fernkraft* act. If the formation of the mouth of the larva of echinoids be taken as another example, the force in question is presumed to operate from the anterior and posterior poles, and at a certain proportionate distance between them; its localization in the median ventral line depends upon the primary bilateral orientation of the whole embryo, which results in the taking on of a unique and special character by that line. The writer shows furthermore that this localizing force may act not only upon the surface of a sphere or other curved surface, but also upon the area between two concentric spheres, etc.

In treating of the relations of the effect (*viz.*, the action of localization) to the cause (the postulated force), Driesch shows that conditions obtain which are very different from those of purely physical or chemical transformations, for the cause is neither transferred quantitatively to the effect, as in mechanical and physical action, nor does it reappear in the effect as a product of the reaction, as in chemical transformations. In the case at hand every specific cause (acting in reference to quantity, *i.e.*, distance) has a corresponding

effect in localization, making possible the attainment of a given end. Such a process Driesch calls undetermined adaptive action or a phenomenon of response.

The author furthermore seeks a functional representation of the events which occur when the course of development is disturbed by an experiment and in which localization phenomena are, of course, implied. That which happens is found to be a function of (1) the final condition (toward which normal development proceeds) and of the condition of the embryo immediately (2) before and (3) after the disturbing act; and, since the third factor is a variable, the process as a whole is of a variable nature. A certain "teleology" is implied in these events and in all ontogenetic processes in that they are the means toward specific ends. Thus the events which follow any disturbance of development are characterized as being dependent upon the final condition. The regulatory phenomena which attend disturbances of mechanical systems, on the other hand, are of a quite different nature, since they are independent of any final condition and depend wholly upon factors that are constant.

Finally, the action of localization is found to be dependent upon the absolute size of the system ( $G$ ), upon the local relations that exist in the complete absolute-normal system ( $R$ ), and on the primary orientation in reference to a definite system of coördinates. If the last factor is assumed to be known, then  $xyz$  (the place) =  $\phi [G.R]$ . This formula is found not to be applicable to inorganic bodies, since in them the localization of specific details of structure is determined by the direct action of external forces without reference at all to the absolute size of the system.

Enough has been shown of Driesch's excellent discussion of these difficult problems of localization to enable the reader to foresee the final conclusion of the author: Since there exists in the processes of ontogenetic differentiation this group of phenomena which are not subordinate to any known laws of inorganic matter, but which make it necessary to assume a special definite elementary action in accordance with fixed laws, it may be regarded as proved that Vitalism, *i.e.*, that conception which sees in life processes events with elementary laws which are peculiar to organic beings, now stands upon a firm foundation.

After a careful study of this important paper the reader will perhaps feel the insufficiency of the postulated localizing *Fernkraft* in itself. Of all that is implied in the "potency" of a "harmonic equipotential system," he would know more. A lingering doubt perhaps

remains in the reader's mind as to whether a fuller knowledge of the "potency" might make the supposition of the *Fernkraft* unnecessary. Cannot formative material operated by chemical and physical forces yet furnish a solution of the problem? Before one is quite converted from the dogmatic materialism of the day to the rational vitalism of Driesch, it is fitting to know well the grounds of the new belief. The phenomena of localization are most admirably analyzed and discussed in the paper under consideration. Other general questions therein implied, as, for instance, Prospective Potency, are ere long to receive, we are informed, a fuller definition and discussion. These further studies will be awaited with much interest.

JOHN H. GEROULD.

**Praxis und Theorie der Zellen- und Befruchtungslehre.<sup>1</sup>—**

This is a book of 260 pages, with 137 text-figures, and is designed to be a practical guide for courses in cytology. As such it cannot fail to be of service, since it is the first work yet published with this distinctive aim. There is, to be sure, in Bergh's *Zelle und Gewebe* an appendix on technique, but this is no more extensive than may be found in many text-books of histology, while the larger works of Hertwig, Wilson, and Henneguy present the facts and theories with regard to the cell from a general rather than from a laboratory standpoint.

As the title indicates, the book also presents in brief form the general facts and theories of cytology, together with a short historical review of different phases of the subject and references to some of the more important literature. This feature of the work, however, lacks the completeness and critical character of the larger works devoted to this field, while the laboratory directions are so interwoven with the general part as to make the book much less readable than the other works mentioned. Unfortunately this combination also renders the book less useful as a laboratory guide, since the directions for preparing and observing material are less concise and explicit, and are much more difficult to find than would otherwise be the case.

The book is the outgrowth of a practical course on the cell given at the Zoölogical Institute at Freiburg, and in conformity with this course the contents are divided into sixteen days, two or three objects being considered each day. The subject for each day and the objects of study are as follows: First Day, Plant and animal

<sup>1</sup> Hacker, Dr. Valentin. Jena, Gustav Fischer, 1899, 7 marks.